Application Design of Intelligent Internet of Vehicles under 5G Communication Technology

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Abstract: ***The rapid promotion of 5G communication technology with the landing and popularization of the application of the Internet of Animals, the Internet of Vehicles as the industry field with the highest maturity and the largest number of connections in the high-speed field of the Internet of Things, the Internet of Vehicles industry has rapidly penetrated, and the industry scale continues to expand. In the Internet of vehicles, due to the mobility of the vehicle itself, on-board vehicular communication has the characteristics of limited mobile area, fast network topology change, frequent access and interruption of the network, large coverage of nodes, and complex communication environment, which brings many difficulties to the implementation of the Internet of vehicles. In view of the above problems, this paper designs an intelligent vehicle networking system integrating sensor-5G communication module system and big data analysis and processing system. The sensor-5G communication module can obtain the sensor data and upload it to the team butler background. The big data analysis and processing system processes, analyzes, manages and tracks the relevant data by monitoring the vehicle data. The application of this system promotes the interconnection between cars and people, and improves the vehicle management efficiency of governments and enterprises.***

Keywords: 5G; Internet of Vehicles; Big data; Sensor; Website.

1. INTRODUCTION

The U.S. Department of Communication and transportation issued a policy in 2015 & mdash; The U.S. Intelligent Transportation System (ITS) Strategic Plan is an upgraded version of the 2010-2014 ITS Strategic Plan, with the core themes of automotive intelligence and connectivity and autonomous control intelligence. In July 2020, China's Ministry of Communication and transportation issued "Guidelines for the Construction of National Vehicle Interconnection System (Intelligent Transportation Related)." July 2021, release policy & mdash; The core content of the Management Standard for the Road Test and Demonstration Application of Intelligent Networked Automobile (Trial) is to guide and regulate the industry in many aspects. According to the statistics of the China connected car industry tracking and overall demand market tracking report 2017-2021, the scale of China's connected car market reached 7.76 billion US dollars in 2016, and it is estimated that the scale of the connected car network market in 2017 is about 11.44 billion US yuan. According to relevant survey estimates, China's connected car market is expected to reach US $216.2 billion in 2025, accounting for 1/4 of the global market, and the average compound growth rate of 4/5 will reach 44.92%. Today, with the empowerment of new technologies such as 5G, AI, IoT, and cloud computing, the development speed of 5G + intelligent transportation and intelligent vehicle industries is rapid.

In view of the above problems, this paper designs a smart car networking system based on 5G communication technology. The system integrates data acquisition system, data upload system, 5G communication technology, Internet of Things hardware technology and big data technology, enabling human-machine interaction between people and cars, creating a true connected car life, and taking people and cars " Car & mdash; Life, closely connected through 5G technology car networking platform, the car and all things connected, targeted planning travel routes, for users to create college, reliable car networking life.

Zhang (2024) investigated the dynamic adaptation of supply and demand for power emergency materials using cohesive hierarchical clustering [1]. For autonomous systems, Tang et al. (2026) proposed SVD-BDRL, a trustworthy autonomous driving decision framework that integrates sparse voxel representations with blockchain technology [2]. Complementing this in perceptual data processing, Xie et al. (2025) developed MARNet, a multi-scale adaptive relational network for robust point cloud completion via cross-modal fusion [3]. Security and privacy in distributed computing remain critical areas of development. Deng and Yang (2025) designed multi-layer defense strategies and privacy-preserving enhancements to counter membership reasoning attacks within federated learning frameworks [4]. In content generation, Lu et al. (2025) introduced NeuroDiff3D, a 3D

generation method that optimizes viewpoint consistency through diffusion modeling [5]. Concurrently, Tu (2025) presented AutoNetTest, a platform-aware framework for intelligent 5G network test automation and issue diagnosis [6]. Foundational work on system reliability and stability modeling continues to progress. Lin et al. (2025) established a Bayesian framework for modeling multivariate degradation data with dynamic covariates [7]. Building on reliability concepts, Zhu (2025) proposed ReliBridge, a scalable LLM-based backbone architecture aimed at ensuring small business platform stability [8]. Further addressing system robustness, Jiang et al. (2025) introduced Perception Characteristics Distance as a metric for measuring the stability and robustness of perception systems under dynamic operating conditions [9]. Finally, novel AI applications are emerging for human-centric and commercial tasks. Xie and Liu (2025) created EvalNet, which utilizes sentiment analysis and multimodal data fusion for recruitment interview processing [10], while Zhang (2025) employed reinforcement learning for automated ad campaign optimization tailored for small businesses [11].

2. 5 G COMMUNICATION TECHNOLOGY

The fifth generation mobile communication (5G) technology uses multi-antenna transmission technology, simultaneous and same-frequency full-duplex technology, Cloud computing and other key technologies, compared with 4G, have higher spectral efficiency and transmission capacity, with high speed, low delay, high reliability and high density [1]. It also covers three major application scenarios: enhanced mobile broadband, massive machine type communication and ultra-high-reliability low-latency communication. The ultimate goal of 5G networks is 10 Gbit / s data rate, 1ms end-to-end latency, 1 million devices per square meter and 100% coverage [2-3]. The application of complex high-speed mobile communication scenarios for connected cars critically requires extremely high network transmission rates and extremely reliable security and stability, which makes 5G network technology the first choice for intelligent connected car system design.

3. OVERALL DESIGN OF THE SYSTEM

The intelligent vehicle networking system designed in this paper combines the Internet of Things technology, 5G wireless network communication technology, Modern technologies such as cloud computing and big data analysis have established a system structure that includes a perception layer, a network interaction layer and a data analysis layer. Cloud computing and big data analysis are used to connect the cars of each node to restore the traffic state in a three-dimensional way, providing reliable basis for road planning and traffic state in service. The system can be structurally divided into four parts: the hardware system, the communication system, the data processing system and the application system, as shown in Figure 1.

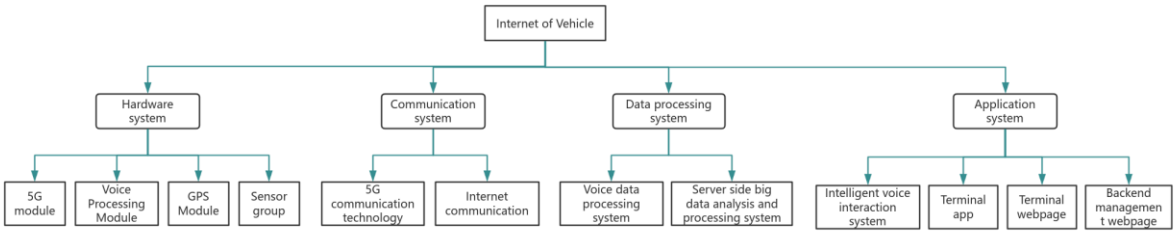

Figure 1: Overall architecture of smart car network

4. INTELLIGENT INTERNET OF VEHICLES HARDWARE SYSTEM

In the intelligent car network system, in order to make the vehicle no longer an independent individual, in addition to obtaining the status information of the running vehicle itself in real time, it also needs to obtain the operation status of other vehicles in the surrounding area, so as to make travel more efficient, safe and reliable. The hardware system in this system comprises a high-performance main control module for processing data and controlling devices, a 5G module for wireless communication, a GPS module for obtaining vehicle location information, a power management module and a sensor group for obtaining the vehicle's own and surrounding vehicle status information, as shown in Figure 2.

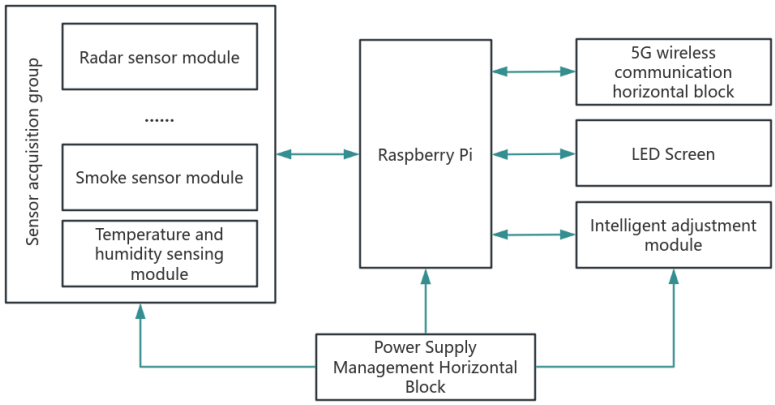

Figure 2: Internet of Vehicles Hardware System

Raspberry Pi CM4 _ 5G expansion board is a 5G development platform based on the CM4 platform. The main resources include: native gigabit, HDMI, 5G modules supporting SA / NSA mode (USB 3.0 interface), an internally reserved 40pin expansion interface, and a 4G module interface, which enables 4G + 5G dual network configuration. The CM4 _ 5G expansion board can not only run Raspberry Pi systems, but also run Ubuntu, Kali and other systems. This paper transports OpenWrt on the Raspberry Pi, which can realize the CPE function. 5G data will be shared with other connected devices in the form of wired and WiFi. Raspberry Pi CM4 platform + 5G module speed test, up to 460 Mbps. Peanut shell intranet penetration is used to map intranet data sensing data to an external web page, and the administrator can view each sensor data at any time on the fleet manager web page.

MQ-2 smoke sensor has the characteristics of fast response time, strong anti-jamming and so on [4]. MQ-2 smoke sensor will be collected smoke concentration signal into appropriate amplitude analog voltage signal, in order to be Raspberry Pi real time processing of the signal, need between smoke sensor and Raspberry Pi access PCF8591 digital-to-analog conversion module, analog signal into digital signal. Raspberry Pi receives the digital signal transmitted by PCF8591, on the one hand, the corresponding smoke concentration value is uploaded to the team butler management background through the 5G module; On the other hand, the corresponding smoke concentration value is compared with the threshold value, and if the typical threshold is exceeded, the alarm is given.

The DHT11 is a temperature and humidity compound transducer with calibrated digital output. The sensor contains an NTC (negative temperature coefficient) temperature sensor, a resistive humidity sensor and an 8-bit microcontroller to convert analog signals from these sensors and generate a digital output signal [5].The humidity measuring range of the temperature and humidity sensor is 5% ~ 95% RH, and the measuring accuracy is & plusmn;5% RH, with a temperature measurement range of -20.0 ~ + 60.0 ° C and a measurement accuracy of 0.2 ° C, can meet the temperature and humidity measurement range and measurement precision of this system. The DHT11 communicates with the Raspberry Pi by using a single bus, which can save system development costs. Raspberry Pi regularly collects the sensor data, on the one hand, the corresponding temperature and humidity values are uploaded to the team butler management background through the 5G module; On the other hand, the corresponding temperature and humidity values are compared to the threshold, and if the typical threshold is exceeded, the alarm is given.

In the application of automotive networking research, automotive collision warning systems are one of the most important research content, especially the collision prevention system with two-way warning functions has great significance for improving the safety of automobiles [5]. The Raspberry Pi collects the vehicle position and the moving speed and time of the target object through the GPS module and the radar module respectively. The main controller uploads the corresponding collected data to the fleet manager management background through the 5G module on the one hand; On the other hand, the corresponding data value is compared with the threshold. If it exceeds the threshold, an alarm is generated.

5. DATA PROCESSING

In the construction of a smart car connected network, a large amount of data information is transmitted to the storage end for storage processing, but traditional servers are difficult to meet the current data computing and storage needs in the connected network. Therefore, in order to realize the data processing functions in the Internet of Vehicles, we need to use the storage capabilities of cloud computing and the computing, processing and analysis capabilities of big data technology. Intelligent technologies such as data mining and analysis based on big data can be used to achieve intelligent management and control, optimize the route, and improve the efficiency and safety of vehicle operation [7].

6. CLIENT DESIGN

6.1 flask framework

Flask is a microframework based on Python and relies on the Jinja2 template engine (which provides web parsing) and the Werkzeug WSGI service (the interface between Python web applications and web services). Because Flask is free, flexible, extensible, and has a wide range of third-party libraries, this paper chooses Flask to build the framework. The client sends the request to the web server, which then sends the requests to the instance of the Flask program, establishes a map between the URL and the Python function, associates the URL with the function that needs to be called, and then finds and calls the specific view function based on each URL request. After the flask is established, the data obtained by the Raspberry Pi can be mapped in real time.

6.2 Background Management Website

The main functions are embodied in Consolidated Inquiry, Vehicle Management, Delivery Management, People Management, Subject Management, Destination Management and System Setup, as shown in Figure 3.

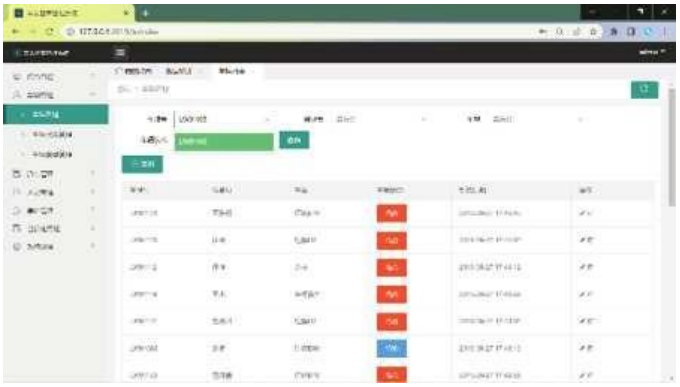

Figure 3: The backstage management website interface

6.2.1 Built-in modules

(1) Comprehensive query: Users can conduct comprehensive query according to the information of the vehicle's department, license plate number, driver's name, user, date, etc.

(2) Vehicle management: Users can conduct single-condition query or multi-condition precise query according to license plate number, driver, vehicle model, vehicle status, etc., and conduct vehicle adding and deleting operations. The category management of models can be carried out accordingly, and the actions of addition and deletion can be performed.

(3) Car management: can carry out the on-line drawing and print preview of the vehicle driving record card, including the department, model, starting point, destination, license plate number, driver name and other content, more comprehensive and detailed grasp of the vehicle status, detailed records of the car situation.

(4) Personnel management: can be used by the person's name, the department, mobile phone number and other conditions for screening and searching, can obtain the detailed driver's ID card number, telephone number, etc., can obtain the department level of the overall driver's situation.

(5) Cause management: You can obtain the specific cause of use and date, and can carry out the operation of adding and deleting.

(6) Destination management: can obtain specific destination by time, date, and can add, delete operations.

(7) System settings: can obtain the use status of the administrator, edit, log in, switch and add different administrator accounts, which is convenient for multiple administrators to use at the same time.

(8) Vehicle-to-vehicle map: real-time access to vehicle location information, to achieve vehicle multi-point positioning, fleet location sharing function. Safety monitoring: When the fleet encounters an emergency, it can click the alarm button, the fleet establishes a connection with the back office, and by monitoring equipment, sensors are perceived, and the back office data is returned by video streaming to observe the situation inside the vehicle in real time.

6.2.2 Introduction of the main technology of the website

(1) Springboot: Springboot is a scaffold，Building on the spring framework and based on the concept of rapid build, which was designed to simplify the development process, Spring Boot integrates many frameworks and third-party library configurations, greatly simplifies XML configuration, and is directly embedded in servers such as Tomcat to quickly build Spring applications.

(2) MyBatis: MyBatis is an excellent persistence layer framework that supports custom SQL, stored procedures, and advanced mapping. Programming based on SQL statements is fairly flexible and does not affect the existing design of the application or database. SQL is written in XML, uncoupling SQL with program code for unified management. Provides XML tags, supports writing dynamic SQL statements, and is reusable.

(3) Mysql: MySQL is a relational database management system that stores data in separate tables rather than all data in one big warehouse, which increases speed and improves flexibility. It has the advantages of small size, fast speed and low overall cost of ownership.

(4) Layui: Layui is an open source Web UI solution that uses its own classic modular specification and follows the native HTML / CSS / JS development approach, often suitable for rapid development of web interfaces. Layui is different from the front end supporter based on MVVM. It is simple and beautiful. It is more for the back end developer. It doesn't need to set foot in the front end. It only needs to face the browser itself.

6.2.3 Website back-end logic

Manage the site by penetrating the intranet of data from the Flask framework site to the backend. Mybatis is different from traditional java web development, sql statement is more centralized, sql statement is put in the xml file, and the codeis separated from sql statement, which reduces the degree of coupling, and is advantageous to modify sql statement because of the change of business requirement. Using Springboot before the development of the basic configuration, the use of maven management jar package, the introduction of mybatis and MySQL key dependencies, in the application.properties file configuration connection data library parameters. We manage SQL statements through mapper.xml. The method names in Dao. java correspond to the id of mapper. xml, and these methods are invoked in the service layer of the interface, parameter passing to the mapper. xml file, and then the corresponding database operations are performed. Synthesis, vehicle management and dispatch in the project are performed in a combination of Springboot and Mybatis. Springboot and layui for data interaction, which uses the controller GetMapping, RequestMapping and PostMapping, such as page jump, to the number of reference library, return data and other functional logic.

7. CONCLUSION

This paper reproduces the traffic state in three dimensions by collecting various data such as traffic trajectory and human flow, and provides drivers with the best travel path. Monitor surrounding pedestrians or vehicles and give early warning based on the results of the main controller and big data analysis to provide users with a safe and reliable travel plan.

REFERENCES

[1] Zhang, X. (2024). Research on Dynamic Adaptation of Supply and Demand of Power Emergency Materials based on Cohesive Hierarchical Clustering. Innovation & Technology Advances, 2(2), 59–75. https://doi.org/10.61187/ita.v2i2.135

[2] Tang, Z., Feng, Y., Zhang, J., & Wang, Z. (2026). SVD-BDRL: A trustworthy autonomous driving decision framework based on sparse voxels and blockchain enhancement. Alexandria Engineering Journal, 134, 433-446.

[3] Xie, J., Zhang, L., Cheng, L., Yao, J., Qian, P., Zhu, B., & Liu, G. (2025). MARNet: Multi-scale adaptive relational network for robust point cloud completion via cross-modal fusion. Information Fusion, 103505.

[4] Deng, X., & Yang, J. (2025, August). Multi-Layer Defense Strategies and Privacy Preserving Enhancements for Membership Reasoning Attacks in a Federated Learning Framework. In 2025 5th International Conference on Computer Science and Blockchain (CCSB) (pp. 278-282). IEEE.

[5] Lu, K., Sui, Q., Chen, X., & Wang, Z. (2025). NeuroDiff3D: a 3D generation method optimizing viewpoint consistency through diffusion modeling. Scientific Reports, 15(1), 41084.

[6] Tu, Tongwei. "AutoNetTest: A Platform-Aware Framework for Intelligent 5G Network Test Automation and Issue Diagnosis." (2025).

[7] Lin, Z., Liu, X., Xiang, Y., & Hong, Y. (2025). Modeling multivariate degradation data with dynamic covariates under a Bayesian framework. Reliability Engineering & System Safety, 111115.

[8] Zhu, Bingxin. "ReliBridge: Scalable LLM-Based Backbone for Small Business Platform Stability." (2025).

[9] Jiang, B., Shi, L., Lin, Z., Stowe, L., & Guo, F. (2025). Perception Characteristics Distance: Measuring Stability and Robustness of Perception System in Dynamic Conditions under a Certain Decision Rule. arXiv preprint arXiv:2506.09217.

[10] Xie, Minhui, and Boyan Liu. "EvalNet: Sentiment Analysis and Multimodal Data Fusion for Recruitment Interview Processing." (2025).

[11] Zhang, Yuhan. "Learning to Advertise: Reinforcement Learning for Automated Ad Campaign Optimization for Small Businesses." (2025).